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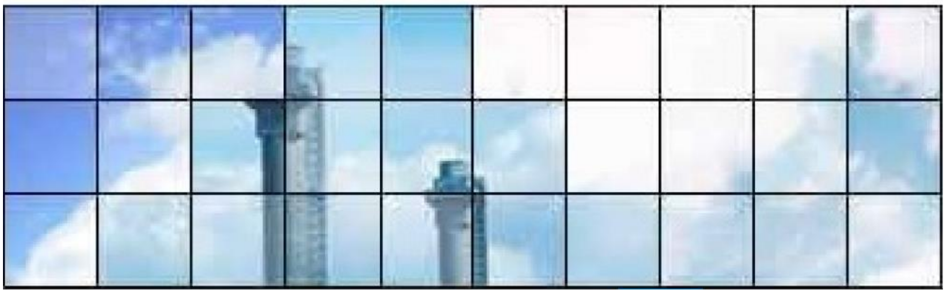

Webinar: Katabatic Flows

13:00-15:30 GMT Wednesday 13 December 2023

Katabatic flows or “cold air drainage” occur primarily at night in still conditions, over sloping complex terrain, when air adjacent to the surface is cooled from below. This nocturnal cooling results in the near-surface air becoming denser than the atmosphere above it, forming a thermally distinct layer which exchanges very little energy with the air above it. The surrounding slopes of the complex terrain facilitate gravitational acceleration of this near surface cold air layer, allowing it to flow or drain downslope where pools can form in local terrain depressions.

While the basic mechanisms underlying katabatic flows can be explained relatively simply in terms of surface radiative cooling, field observations and numerical simulations have identified subtle and nontrivial features characterising different kinds of katabatic flows. For example, in reality, the contribution from advection due to local drainage features plays a major role in the development of katabatic flows[1]. Due to the spatial scale of the phenomena and the density of instrumentation required to adequately resolve the range of temporal scales over which the near-surface temperature fields that drive katabatic flow evolve, practical experiments to understand katabatic flow in complex terrain, and hence develop better and more accurate computer models, remain limited.

While katabatic flows can occur on scales ranging from several hundreds of metres to many kilometres, this process is of particular interest at a micrometeorological scale where it may play a significant role in concentrating pollutants over short timescales. Pollutants released at or near ground level can remain “trapped” within these drainage layers, while pollutants released above the drainage layer may subsequently become entrained into the layer, significantly affecting local concentrations.

Dispersion characteristics within these katabatic flow layers may be very different from those for stable flows over flat terrain and, while the majority of commercially available dispersion modelling software incorporates methods for assessing the impact of complex terrain on dispersion, characteristics associated with katabatic flows are not specifically accounted for. Where they are considered, they are often applied imperfectly due to the adoption of assumptions such as steady flow, constant layer depth and flow parallel to terrain which help to simplify calculations and reduce computation time.

Stiperski, I., Holtslag, A.A.M., Lehner, M., Hoch, S.W. and Whiteman, C.D. (2020) On the turbulence structure of deep katabatic flows on a gentle mesoscale slope. Quarterly Journal of the Royal Meteorological Society, 146, 1206-1231. https://doi.org/10.1002/qj.3734

Drake, S.; Higgins, C.;Pardyjak, E. (2021) Distinguishing Time Scales of Katabatic Flow in Complex Terrain. Atmosphere, 12, 1651. https://doi.org/10.3390/atmos12121651

Arrillaga, J.A., Yagüe, C., Román-Cascón, C., Sastre, M., Jiménez, M.A., Maqueda, G. and Vilà-Guerau de Arellano, J. (2019) From weak to intense downslope winds: origin, interaction with boundary-layer turbulence and impact on CO2 variability. Atmospheric Chemistry and Physics, 19, 4615–4635. https://doi.org/10.5194/acp-19-4615-2019

Farina, S. and Zardi, D. (2023) Understanding Thermally Driven Slope Winds: Recent Advances and Open Questions. Boundary-Layer Meteorology. https://doi.org/10.1007/s10546-023-00821-1

Despite increases in computing power in recent years, computer models remain limited in both the spatial and temporal scales they can realistically simulate. For example, realistic modelling of katabatic flow development which adequately captures the timescale variability due to the interaction with small-scale topographic features, which increase with terrain complexity, remains difficult to implement.

Our ongoing challenges remain better parameterizations of surface layer processes driving the formation of thermally-driven flows and boundary layer formation over slopes in complex terrain, and developing a better understanding of how we can incorporate these processes into the modelling of pollutant dispersion.

The webinar will follow a similar format to previous ADMLC webinars (see https://admlc.com/events) with some introductory remarks to set the scene and six 20 minute talks, followed by a discussion session, where active participation from the audience is encouraged. A list of the speakers is given below:

- **Ji Ping Shi (NRW) "**Welcome and introduction to the webinar" (5 min)
- **Silvana Di Sabatino (University of Bologna) "**Characteristics of the nocturnal boundary layer using data from the MATERHORN experiment" (20 min)
- **Koßmann Meinolf (Deutscher Wetterdienst) "**DWD studies on nocturnal thermally driven flows in hilly and urban terrain**"** (20 min)
- **Roger Timmis (EA) & John Moncrieff (Edinburgh University**) "Cold-air drainage: observations, simulations and potential regulatory implications" (40 min)
- **Matt Bevington & Neil Davies (NRW)** "A Case Study Using KLAM Model" (20 min)
- **David Carruthers (CERC)** "Modelling flow and dispersion for low wind speeds over complex terrain with FLOWSTAR and ADMS" (20 min)
- **Discussion** (25 min)

Our hope is that the webinar will bring together representatives from industry, academia, government departments and consultancies, and provide an opportunity to share knowledge and experience in this field. The webinar is free to attend and will be hosted on Microsoft Teams. If you would like to register for the event, please email: admlc@ukhsa.gov.uk.